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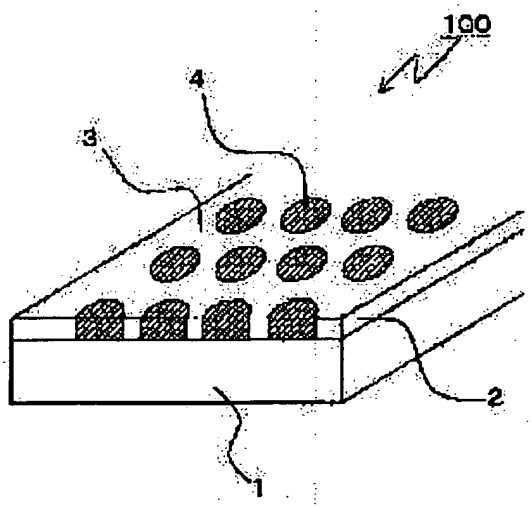
(54) INFORMATION RECORDING MEDIUM AND ITS MANUFACTURING METHOD

(57)Abstract:

PROBLEM TO BE SOLVED: To provide an information recording medium provided with a magnetic film having a new structure capable of super high density recording and to provide a method for manufacturing the information recording medium.

SOLUTION: The information recording medium 100 is provided with an oxide magnetic film 2 constituted of a non-magnetic region 3 and a magnetic region 4 on a substrate 1. The magnetic region 4 is composed of plural sections which are formed so as to be isolated from one another by the non-magnetic region 3. Since each section of the magnetic region 4 is not affected by the magnetic interaction between one another, each section can be stably exist and also has high thermal fluctuation resistance. The information recording medium capable of super high density recording is realized by imparting information of 1 bit to each section of the magnetic region.



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CLAIMS

[Claim(s)]
[Claim 1] The information record medium which is an information record medium equipped with an oxide magnetic film on a substrate, and is characterized by the above-mentioned oxide magnetic film consisting of a magnetic field and a nonmagnetic field.
[Claim 2] The information record medium according to claim 1 characterized by for the above-mentioned magnetic field having two or more partitions, and these two or more partitions being mutually isolated by the nonmagnetic field.
[Claim 3] The information record medium according to claim 1 or 2 characterized by recording information on the above-mentioned magnetic field.
[Claim 4] The above-mentioned oxide magnetic film is an information record medium given in any 1 term of claims 1-3 characterized by consisting of a ferrite or chrome oxide.
[Claim 5] The magnetic pattern formation approach characterized by performing ion implantation to a magnetic film so that it may be the approach of forming a magnetic pattern in a magnetic film and only the predetermined field of the above-mentioned magnetic film may become nonmagnetic.
[Claim 6] The magnetic pattern formation approach according to claim 5 characterized by the above-mentioned magnetic film consisting of oxide magnetic compacts.
[Claim 7] The magnetic pattern formation approach according to claim 5 or 6 characterized by the ion used by the above-mentioned ion implantation being rare gas ion.
[Claim 8] The magnetic pattern formation approach given in any 1 term of claims 5-7 characterized by using FIB for the above-mentioned ion implantation.
[Claim 9] The magnetic pattern formation approach given in any 1 term of claims 5-7 characterized by forming a mask on the above-mentioned magnetic film, and performing ion implantation from on a mask.
[Claim 10] The information record medium which has the magnetic film with which the magnetic pattern was formed in any 1 term of claims 5-9 using the magnetic pattern formation approach of a publication.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the information record medium which has the new structure which was suitable for high density magnetic recording at the detail, and its manufacture approach further about the information record medium equipped with a magnetic material as an information recording layer, and its manufacture approach.
[0002]
[Description of the Prior Art] The magnetic disk is widely used as main information record media supporting this with progress of an information network, and the spread of multimedia. In recent years, the amount of information is huge and graphical data, dynamic-image data, document data, etc. have become one of the technical technical problems with most important raising surface recording density in a magnetic disk.
[0003] In order to raise the recording density of a magnetic disk, it is known that what is necessary is just to make the magnetic particle as a record unit small. In a magnetic disk, in the case of informational record or playback, a field is impressed by the magnetic head, and flux reversal of two or more magnetic particles is carried out collectively. And more than one are collected and the magnetic particle group which carried out flux reversal is constituted as a record magnetic domain (record unit). So, in order to realize high density magnetic recording, at the time of record or elimination, the number of the magnetic particles which carry out flux reversal is lessened, or it is necessary to make each magnetic particle detailed. However, when a magnetic particle was micrified, heat fluctuation arose and there was a problem that the data which it becomes impossible for magnetization of a magnetic particle to have existed in stability, and it recorded will disappear. Moreover, if the magnetic interaction which the magnetic interaction is committing between magnetic particles and is committed between magnetic particles is strong, the number of the magnetic particles which carry out flux reversal will also increase, and it will become the hindrance of high density magnetic recording. So, how to weaken the magnetic interaction which a magnetic particle is isolated magnetically and committed between magnetic particles is also examined.
[0004] Moreover, the vertical magnetic recording and the vertical-magnetic-recording medium which record information perpendicularly to a record film surface are also proposed as one means of the formation of high density record using the magnetic film which has perpendicular magnetization as record film.
[0005]
[Problem(s) to be Solved by the Invention] By the way, the magnetic disk which has the structure where many single domains were uniformly embedded on the nonmagnetic disk as a magnetic disk for high density record is indicated by "J.Magn.Soc.Japan, Vol.21, No.7, and 1997p1023-1032." Since each record part (single domain) is isolated magnetically and formed, high density record is possible for this magnetic disk. However, the manufacture approach of the magnetic disk indicated by this reference was the approach of forming a crevice in the non-magnetic material formed on the substrate, and filling up this crevice with a magnetic material, and since a magnetic disk was manufactured through many processes of electron-beam lithography, a development, chromium etching, reactive ion etching, electrocasting, and mechanical chemical polish, productivity was not bad practical [the approach]. Moreover, the crevice formed on the silicon nitride whose magnetic disk of this reference is a non-magnetic material is filled up with the magnetic material, and the nonmagnetic part and the magnetic part consist of mutually different ingredients.
[0006] This invention is made in view of this situation, and the 1st purpose of this invention is to offer the information

record medium equipped with the magnetic film of the new structure of having a magnetic field to a nonmagnetic field for super-high density record.
[0007] The 2nd purpose of this invention is to offer the formation approach of the suitable new magnetic pattern for manufacture of an information record medium equipped with the magnetic film which has the structure where the magnetic field was formed in the nonmagnetic field.
[0008]
[Means for Solving the Problem] If the 1st mode of this invention is followed, it will be the information record medium equipped with an oxide magnetic film on a substrate, and the information record medium characterized by the above-mentioned oxide magnetic film consisting of a magnetic field and a nonmagnetic field will be offered.
[0009] The information record medium of this invention is equipped with the oxide magnetic film which has a magnetic field and a nonmagnetic field. The magnetic field which exists in this oxide magnetic film can be regularly arranged in a nonmagnetic field. For example, a magnetic interaction can be made to intercept between each magnetic partition by constituting a magnetic field from two or more magnetic partitions, and forming so that those partitions may be mutually isolated in a nonmagnetic field. If a magnetic field is used as a record section, it becomes possible to give 1-bit information to each magnetic partition which exists in a magnetic film, and high density magnetic recording can be realized. Moreover, the magnetic field itself can also be constituted as a single domain. Since the nonmagnetic field and magnetism field also consists of same oxide magnetic materials, the information record medium of this invention differs from the magnetic disk indicated by the above-mentioned reference.
[0010] In the information record medium of this invention, oxide magnetic films may be perpendicular magnetic anisotropy films which are suitable in the direction perpendicular to a film surface, even if an easy direction of magnetization is the magnetization film within a field which is suitable in the direction parallel to a film surface. As an ingredient which constitutes an oxide magnetic film, it is desirable to, use magnetic materials, such as hexagonal ferrites, such as spinel ferrites, such as gamma-Fe 2O3, and a garnet ferrite, Ba ferrite, and chrome oxide like CrO2, for example.
[0011] In the information record medium of this invention, the nonmagnetic field of an oxide magnetic layer can be formed by the ion implantation mentioned later. Although this nonmagnetic field has the same crystal structure as fundamentally as a magnetic field, it has turbulence and the defect of few crystal periods by having driven in ion. Such turbulence and a defect of a crystal period can be checked by analysis which used electron diffraction etc.
[0012] In order to record or eliminate information to the magnetic-recording medium of this invention, the principle of a magnetic force microscope is applicable. That is, if it is made to make the polar field according to information impress to a magnetic field, making this component scan on a magnetic-recording medium using the component (magnetic probe) for detecting the MAG from a sample in a magnetic force microscope, information is recordable on a magnetic field. Moreover, when reproducing information, the observation principle of a magnetic force microscope can be used similarly. In this case, what is necessary is to detect that the force which a magnetic probe receives according to magnetization of the magnetic field of a magnetic-recording medium changes, and just to reproduce information, when the above-mentioned component, i.e., a magnetic probe, is made to scan on a magnetic-recording medium.
[0013] If the 2nd mode of this invention is followed, it will be the approach of forming a magnetic pattern in a magnetic film, and the magnetic pattern formation approach characterized by performing ion implantation to a magnetic film will be offered so that only the predetermined field of the above-mentioned magnetic film may become nonmagnetic.
[0014] By the magnetic pattern formation approach of this invention, the magnetic pattern constituted from a magnetic field and a nonmagnetic field by the magnetic film is formed by driving ion into a magnetic film. The mask which consists of the approach of driving direct ion into the field of a request of a magnetic film using FIB (Focused Ion Beam; focused ion beam), a resist which has a desired pattern on a magnetic film can be formed in placing of the ion to a magnetic film, and the approach of driving in ion through a mask etc. can be used for it. For example, the nano imprint method, a photo-mask process, an electron ray drawing process, etc. can be used for formation of the mask pattern to a magnetic film top.
[0015] As for the magnetic film with which ion is driven in, in the magnetic pattern formation approach of this invention, it is desirable to consist of oxide magnetic compacts. The oxide magnetic compact has the property in which the magnetism of the part tends to disappear, if the ion of the specified quantity is driven in. So, the magnetic pattern

constituted from a magnetic field and a nonmagnetic field by the magnetic film can be formed very easily.
[0016] In the magnetic pattern formation approach of this invention, the dimension of a magnetic field and spacing with an adjacent magnetic field can be suitably adjusted by changing the pattern of a mask. Moreover, by the magnetic pattern formation approach of this invention, the magnetic field formed all over a nonmagnetic field can be formed in configurations of arbitration, such as a round shape, and an ellipse form, a rectangle. For example, what is necessary is just to constitute a mask pattern so that the field where ion is not driven in may become a round shape, an ellipse form, and a rectangle in forming a magnetic pattern by the ion implantation which used the mask for the magnetic film.
[0017] In this invention, as for the ion used by ion implantation, it is desirable that it is inactive, for example, Ne ion and Ar ion can be used.
[0018]
[Embodiment of the Invention] Although the example of the information record medium according to this invention is explained concretely hereafter, this invention is not limited to this.
[0019]
[Example 1] The outline of the cross-section structure of a magnetic-recording medium of following this invention is shown in drawing 1 . The oxide magnetic film 2 is formed on the substrate 1, to the oxide magnetic film 2, the magnetic field (field of the inside of drawing and a slash) 4 is isolated, and the magnetic-recording medium 100 is formed in the nonmagnetic field 3 at it. The manufacture approach of this magnetic-recording medium 100 is explained below.
[0020] First, the glass substrate 1 with a diameter of 45mm is prepared (drawing 2 (A)). Subsequently, as shown in drawing 2 (B), the hexagonal ferrite which shows perpendicular magnetization is formed by 20nm of thickness as an oxide magnetic film 2 on this substrate 1. A spatter can be used for membrane formation of the oxide magnetic film 2. Next, the photoresist 5 which consists of polymethylmethacrylate is applied in 150nm of thickness on the oxide magnetic film 2 (drawing 2 (C)).
[0021] Subsequently, as shown in drawing 2 (D), a crevice prepares La Stampa (mold) 6 in which the concavo-convex pattern of a circle configuration was formed, by **********ing this La Stampa 6 by the predetermined pressure on a photoresist 5, a photoresist 5 is made to transform and a concavo-convex pattern is imprinted on the front face of a photoresist 5. The heights of a circle configuration are uniformly formed in a photoresist 5 of this stamping, and the thickness of 200nm and a crevice is set to 50nm by the thickness of the heights of a circle configuration.
[0022] Subsequently, as shown in drawing 2 (E), Ne+ of 100keV is driven in by the consistency of 1.5x1014-/cm2 on the front face of the photoresist 5 in which the concavo-convex pattern was formed. By this ion implantation, Ne+ penetrates only the thin crevice of thickness, without the ability penetrating the thick heights of the thickness of a photoresist 5. So, the oxide magnetic film 2 of the field where Ne+ was driven only into the oxide magnetic film 2 which exists directly under the crevice of a photoresist 5, and Ne+ was driven in becomes nonmagnetic. After ending ion implantation, the magnetic-recording medium which has the laminated structure shown in drawing 2 (F) is produced by removing the photoresist 5 on the oxide magnetic film 2 in reactive ion etching using fluorine system gas, using a developer. If the front face of the oxide magnetic film of the obtained magnetic-recording medium is lightly etched with a phosphoric acid etc., since the field (ion implantation field) where ion was driven in has the etch rate larger than the field (non-ion implantation field) where ion was not driven in, in the ion implantation field and the non-ion implantation field, the level difference has produced it. If the front face of the oxide magnetic film etched based on this effectiveness is observed using a scanning electron microscope, the magnetic field of a circle configuration is formed all over the nonmagnetic field as shown in drawing 1 .
[0023]
[Example 2] In this example, a magnetic-recording medium is produced like an example 1 except a crevice forming a concavo-convex pattern on a photoresist using La Stampa which has a concavo-convex rectangle-like pattern. The outline perspective view of this magnetic-recording medium 300 is shown in drawing 3 . As shown in drawing 3 , truck lay length forms the magnetic rectangle-like field (Records Department) 4 whose die length of 20nm and the truck cross direction is 60nm at intervals of 40nm on the truck of a magnetic film 2. A track pitch is 80nm. The recording density of this magnetic-recording medium 300 is equivalent to 2 (about 31 Gbits/cm2) 200 Gbits(es)/inch.
[0024] By performing initialization processing to the magnetic field 4 of the magnetic-recording medium 300, the magnetization direction of the magnetic field 4 is arranged in the fixed direction. Information is recordable on this

magnetic-recording medium 300 using the magnetic head 200 which has the structure shown in drawing 4 . The major-axis lay length L1 has the dimension 50nm and whose minor-axis lay length L2 are 20nm, and can form the field impression part 21 of the magnetic head 200 with the micro-machining technique using FIB etc. Since the convergent magnetic flux with narrow width of face occurs from the field impression part 21 of this magnetic head 300, a field can be impressed only to the magnetic field of the request on a magnetic-recording medium. That is, a field can be certainly impressed to each minute magnetic field of a magnetic-recording medium, and magnetization of a magnetic field can be reversed. When the magnetic field of the magnetic-recording medium after information record is observed under a magnetic force microscope, it turns out that it has the magnetization according to recording information of each magnetic field.

[0025] As mentioned above, although the example explained concretely the information record medium according to this invention, this invention is not limited to these. In the above-mentioned example 1, although the spatter was used for membrane formation of the oxide magnetic film on a substrate, a magnetic film may be formed by not only this but the CVD method, and liquid phase epitaxy.

[0026] Moreover, although pattern NINGU of a resist was performed in the example 1 using the nano imprint method which forces La Stampa on a resist and forms a concavo-convex pattern, a photo-mask process and an electron ray drawing process can also be used. Moreover, a nonmagnetic field may be formed in a magnetic film by driving direct ion into the predetermined field of a magnetic film by FIB, without forming a mask on a magnetic film.

[0027] Moreover, although the magnetic-recording medium equipped with an oxide magnetic film on a substrate was produced in the above-mentioned examples 1 and 2, it cannot be overemphasized that it is possible for the information record medium of this invention not to be limited to this laminated structure, and to form a substrate layer, a protective layer, etc. in the location of arbitration if needed.

[0028]

[Effect of the Invention] By equipping the information record medium of this invention with the oxide magnetic film which consisted of a magnetic field and a nonmagnetic field, and constituting a magnetic field from two or more partitions mutually isolated by for example, the nonmagnetic field, it is stabilized, and the partition of these plurality exists, without receiving a magnetic interaction mutually, and is strong also to heat fluctuation. So, the super-high density record medium which has the surface recording density exceeding 2 100 Gbit/inch is realizable by giving each of two or more partitions 1-bit information, and recording information.

[0029] According to the magnetic pattern formation approach of this invention, it can form in the nonmagnetic field of a magnetic film very easily in the configuration of a request of a magnetic field only by driving ion into a magnetic film. So, it is very suitable as an approach of producing a magnetic film with which a magnetic field is formed in a nonmagnetic field by being isolated like the magnetic film of the information record medium of this invention, and enables this to produce a super-high density record medium very easily.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the outline perspective view of an information record medium according to this invention, and signs that the magnetic field of a circle configuration is formed all over the nonmagnetic field of an oxide magnetic film are shown.
[Drawing 2] It is drawing for explaining how driving ion into a magnetic film and forming a magnetic pattern.
[Drawing 3] It is the outline perspective view of the magnetic-recording medium produced in the example 2, and signs that the magnetic rectangle-like field is formed all over the nonmagnetic field of an oxide magnetic film are shown.
[Drawing 4] It is the outline sectional view of the magnetic head of the single magnetic pole mold for impressing the field of a magnetic-recording medium.
[Description of Notations]
1 Substrate
2 Oxide Magnetic Film
3 Nonmagnetic Field
4 Magnetic Field
5 Photoresist
6 La Stampa
100,300 Magnetic-recording medium

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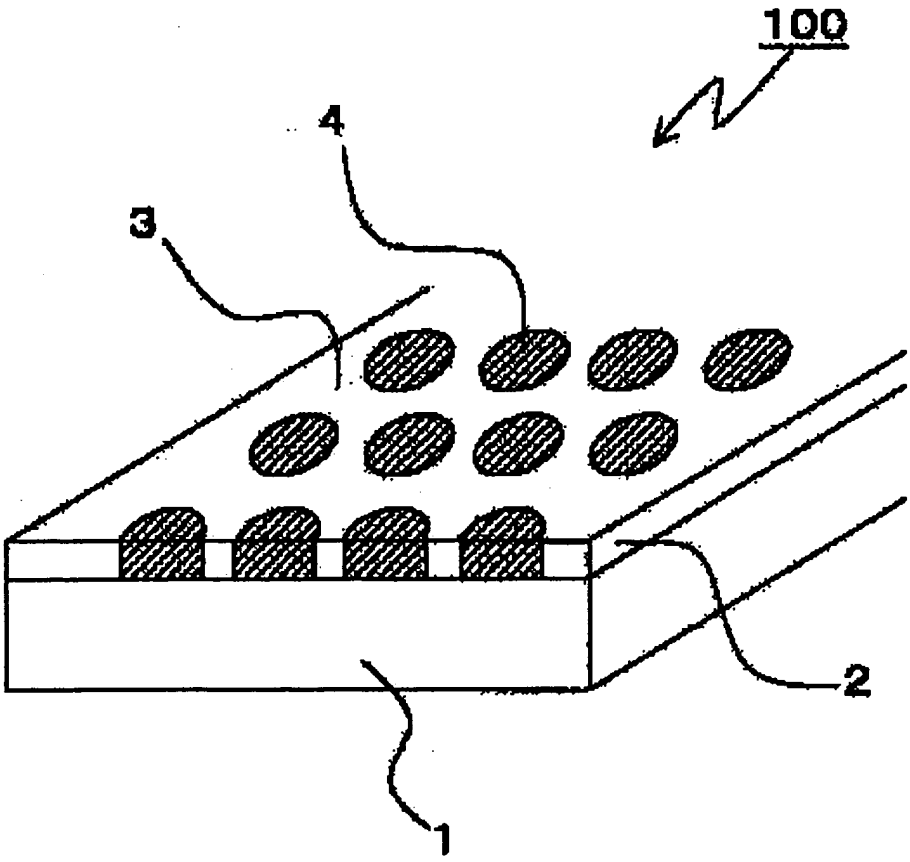
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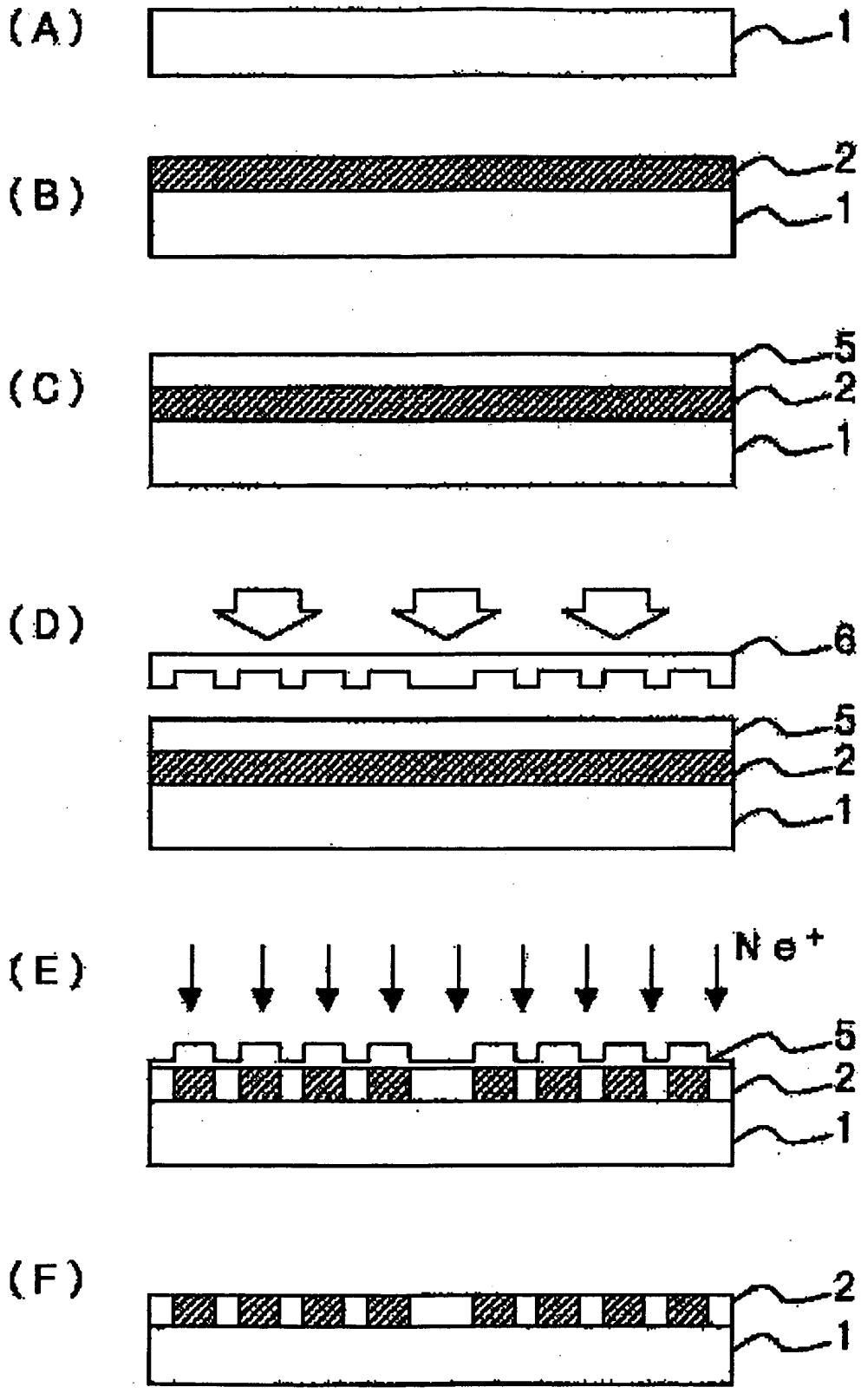
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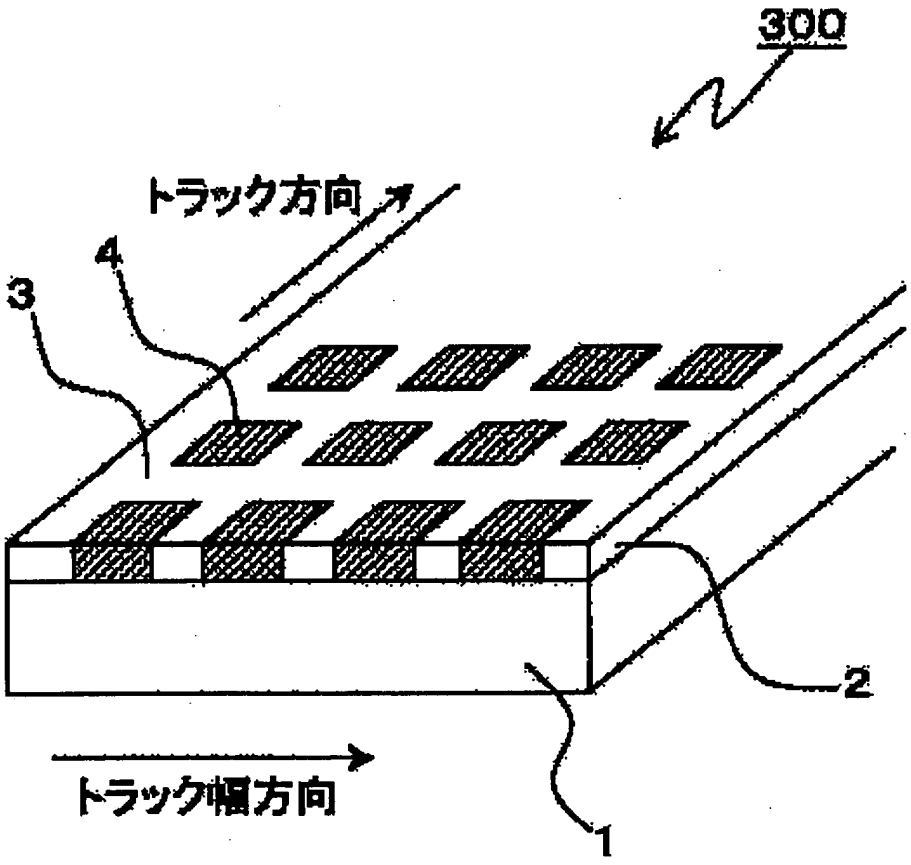
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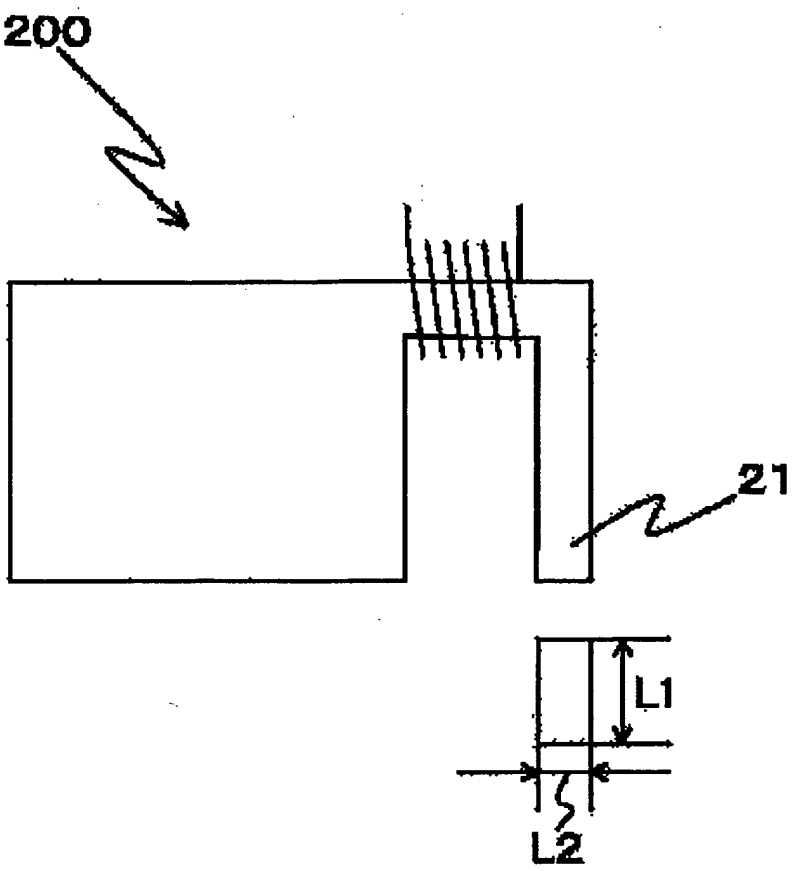
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